The Effect on the Geomagnetic Field of the Total Solar Eclipse of 5 February 1962 and the Corpuscular Eclipse of the Solar Corpuscular Bean on the Surface of the Boundary of Geomagnetic Cavity.

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The Effect on the Geomagnetic Field of the Total Solar Eclipse of 5 February 1962 and the Corpuscular Eclipse of the Solar Corpuscular Beam on the Surface of the Boundary of Geomagnetic Cavity

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Abstract

In order to observe the effect on the geomagnetic field of the solar eclipse of February 5, 1962 at Lae, New Guinea, the author observed the geomagnetic field by the Askania type field magnetometer and also observed the geomagnetic pulsation by the induction magnetometer.

While the magnetic storm with sudden commencement occured at 19^h30^m, February 4 (150° E.M.T.) and this magnetic storm still continued at the time of the solar eclipse of February 5. Therefore it is too complicate to study the effect on the geomagnetic daily variation of this solar eclipse.

On the other hand we could observe the geomagnetic micropulsation accompanying this magnetic storm, and it is very interesting that the effect on this magnetic micropulsation of the solar eclipse was observed, that is the direction of the principal axis of the vector diagrams of these geomagnetic micropulsations changed during the solar eclipse. This character is expected if the electrical conductivity in the ionosphere decreased at the time of eclipse as observed by the Radio Research Laboratory at same place.

On the other hand the zone of the totality of the corpuscular eclipse of the solar corpuscular beam of this storm on the surface of the magnetopause was calculated.

It is very interesting that the effect of the corpuscular eclipse on the surface of the boundary of the geomagnetic cavity, whose radius is six earth radii, was observed too, and this effect is expected as the hydromagnetic disturbance excited on the boundary of the magnetic cavity due to the moon's shadow of the solar wind or the lunar hydrodynamic wake staying few hours on the same place on the boundary of the magnetopause.

Introduction

The present author observed the effect of the solar eclipse on the geomagnetic field at Ceylon at the time of the solar eclipse of 20 June 1955 and the clear effect was observed (1).

The author observed again the effect of the solar eclipse on the daily variation of the geomagnetic field at Suwarrow Island in the South Pacific Ocean at the time of the total solar eclipse of 12 October 1958 and succeeded in observing the eclipse effect very distinctly (2), this was so distinct and conclusive as to leave no room for doubt on this topic "the effect on the daily variation of the geomagnetic field of the solar eclipse" which had attracted attention since the beginning of this century.

On the other hand, the geomagnetic micropulsation has become to have more important significance in geophysics.

The author observed the effect on the geomagnetic micropulsation of the solar eclipse of 20 July 1963 at Northway, Alaska because the total zone of this eclipse crossed just under the auroral zone at Alaska and succeded in observing the effect of the solar eclipse on the geomagnetic micropulsation (pc 3) very distinctly (3).

The direction of the principal axis of the vector diagram of these geomagnetic micropulsation was changed when the eclipse began and shifted about 90 degrees from the initial state at the time of totality and recovered again to the initial state when the eclipse ended.

In this paper, the author studied the effect on the geomagnetic micropulsation caused by the magnetic storm of the total solar eclipse of 5 February 1962. At this time, the typical magnetic strom with sudden commencement occured on 4 February and it still continued during this solar eclipse, while the direction of the principal axis of the vector diagram of these magnetic micropulsation changed during this eclipse, too.

This character is expected if the conductivity in the ionosphere was decreased during the eclipse as was observed by the Radio Research Laboratory at this time at same place.

On the other hand, the corpuscular eclipse of the solar corpuscular beam which is the origin of this magnetic storm, on the surface of the boundary of the magnetic cavity was calculated and it is very interesting that the effect of this corpuscular eclipse on the geomagnetic field was observed. This may be the hydromagnetic disturbance excited on the boundary of the geomagnetic cavity caused by this corpuscular eclipse.

Effect on the geomagnetic micropulsation.

Askania type field magnetometer and the induction magnetometer were used to observe the effect of the solar eclipse on the geomagnetic field or the geomagnetic micropulsation of 5 February 1962 at Lae, New Guinea.

The observation camp was established in the bush near the lodge of Trans Australia Airline at Lae.

The location and its situation of the camp is as follows.

Latitude	6°43′S
Longitude	147°00′E
Horizontal Component	36775 γ 16^h12^m Feb. 4 (150°E.M.T.)
Declination	5°36′1E 16^h49^m Feb. 4
Dip	−27°32′2 17^h40^m Feb. 4

The magnetic storm with sudden commencement occured on 19^h30^m Feb. 4 (150° E.M.T.) and this magnetic storm still continued at the time of the solar eclipse of Feb. 5 as shown in Fig. 12.

The geomagnetic micropulsation accompanying this magnetic storm was observed as shown in Fig. 2–Fig. 5. As the figures show it is very clear that the mode of oscillation of the micropulsation is changed very distinctly during the eclipse.

Fig. 6 shows the direction of the principal axis of the vector diagram of the

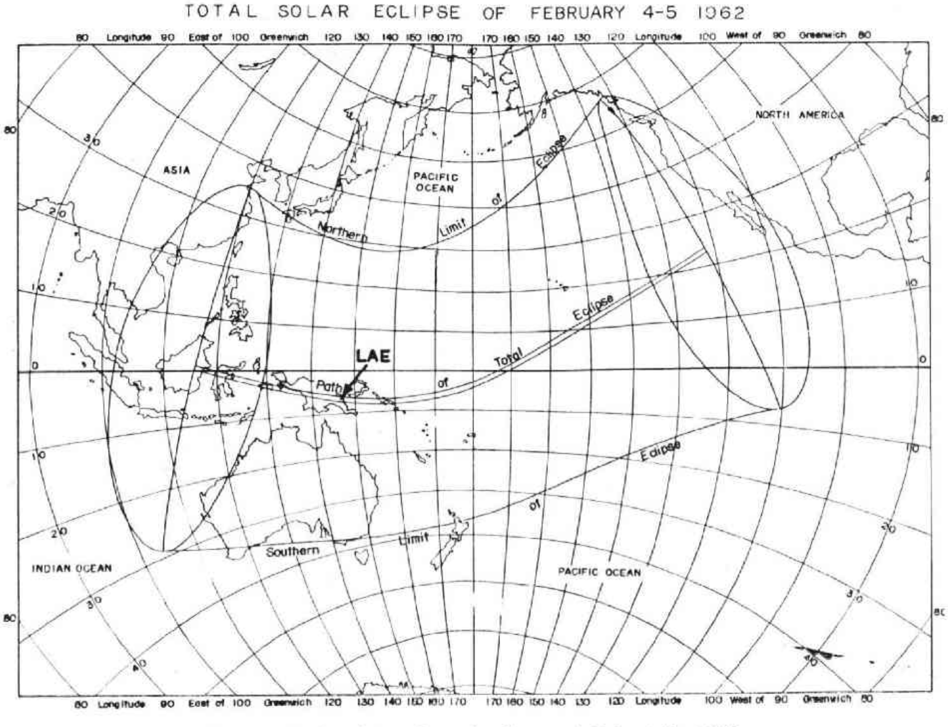

Fig. 1 Path of totality of eclipse of Feb. 4-5, 1962.

micropulsation.

The figure shows that the direction of the principal axis is NE-SW before the eclipse. The direction shifted to N-S just after the totality and recovered to initial state about 30 minutes after totality.

Fig. 6 shows the shifts of the direction of the principal axis, and is considered as the eclipse effect on the geomagnetic micropulsations.

This characters were observed also at the time of solar eclipse of 20 July 1963 at Alaska (3), (4).

The incident hydromagnetic wave comes downward to the ionosphere and the electric current will be induced in the ionosphere.

If the electrical conductivity of the ionosphere decreases at the time of eclipse as was observed by Radio Research Laboratory (Fig. 7), the stream line of the current deflects its direction and flows around its decreased area. Therefore the principal axis of the oscillating magnetic field due to this oscillating current changes at the time of the eclipse. A calculation was made and published in the previous paper (3), (4).

Corpuscular eclipse on the surface of the magnetopause of Feb. 5, 1962.

By the recent satelite observation, it becomes clear that the earth's magnetic field is confined within the magnetosphere and there is a boundary between the magnetosphere and interplanetary space.

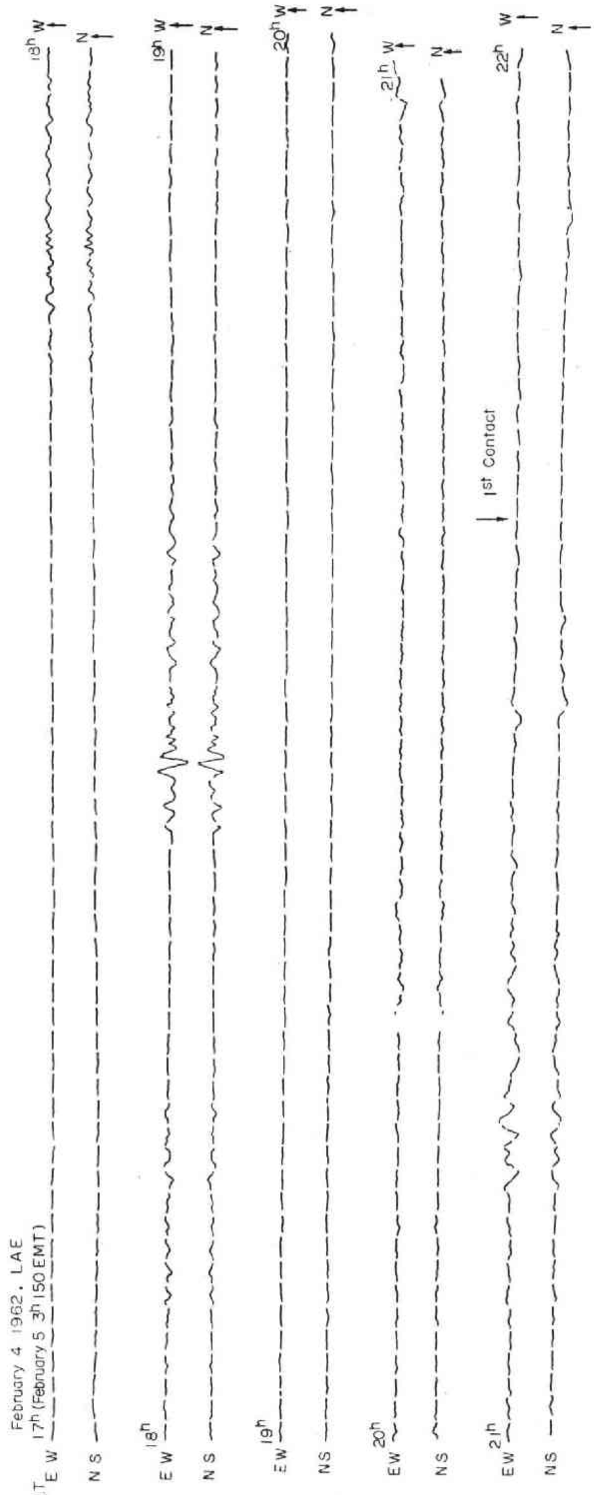

Fig. 2 Induction magnetograph obtained at Lae, Feb. 4-5, 1962.

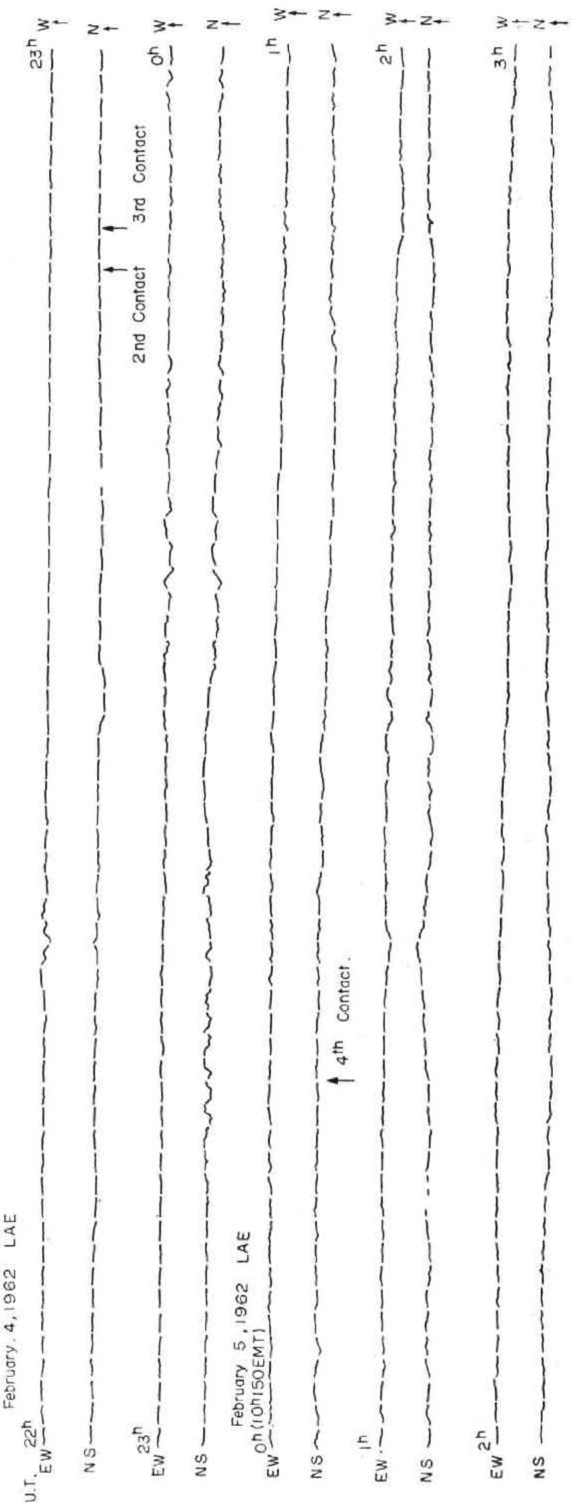

Fig. 3 Induction magnetograph obtained at Lae, Eeb.4-5, 1962.

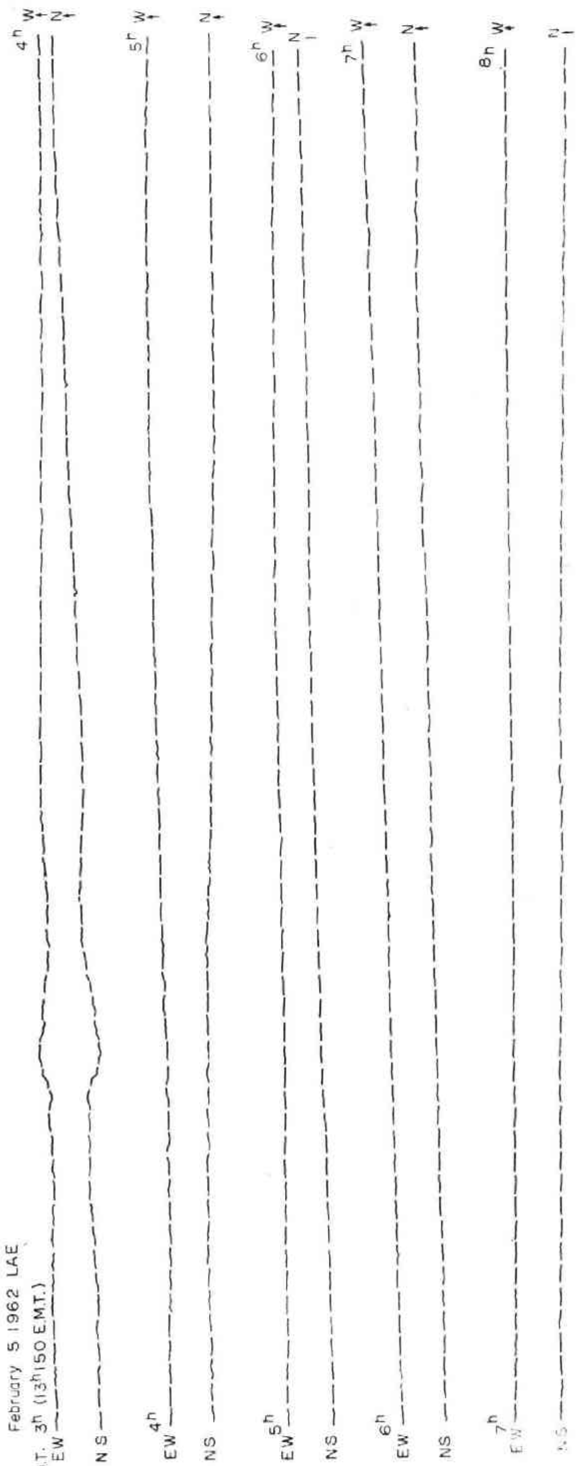

Fig. 4 Induction magnetograph obtained at Lae, Feb. 4-5, 1962.

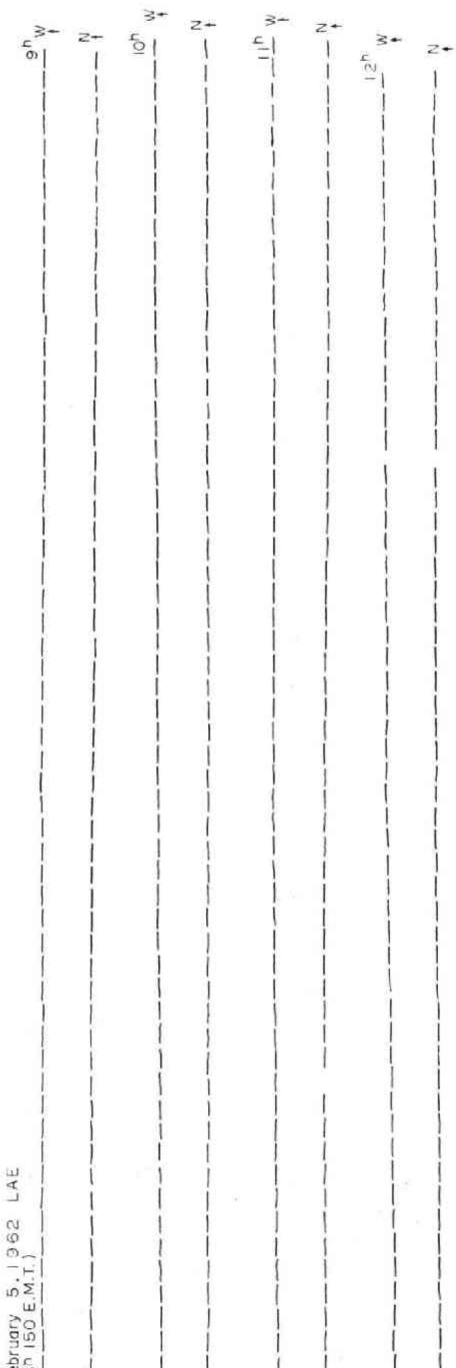

Fig. 5 Induction magnetograph obtained at Lae, Feb.4-5, 1962.

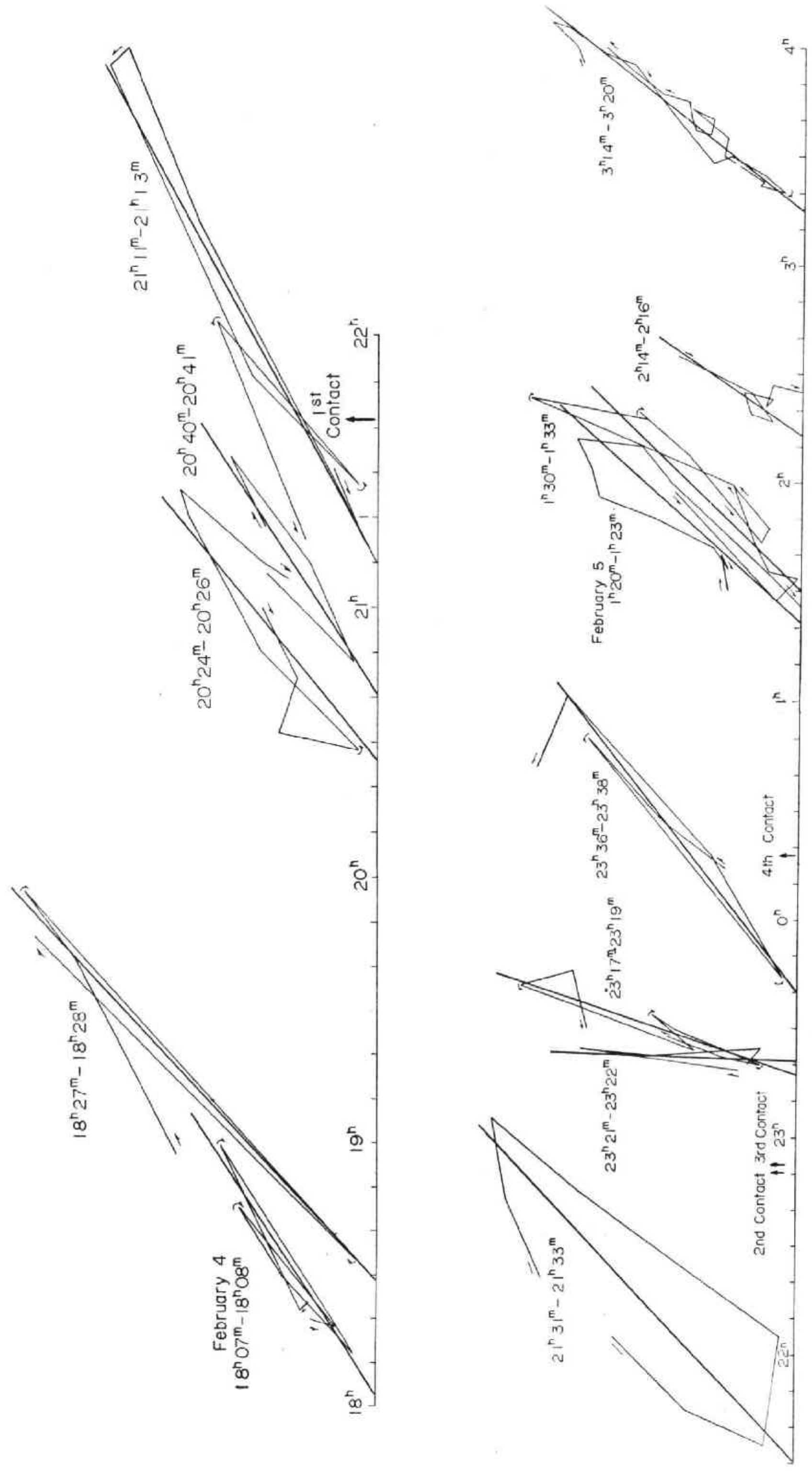

Fig. 6 Direction of the principal axis of vector of m cropulsation.

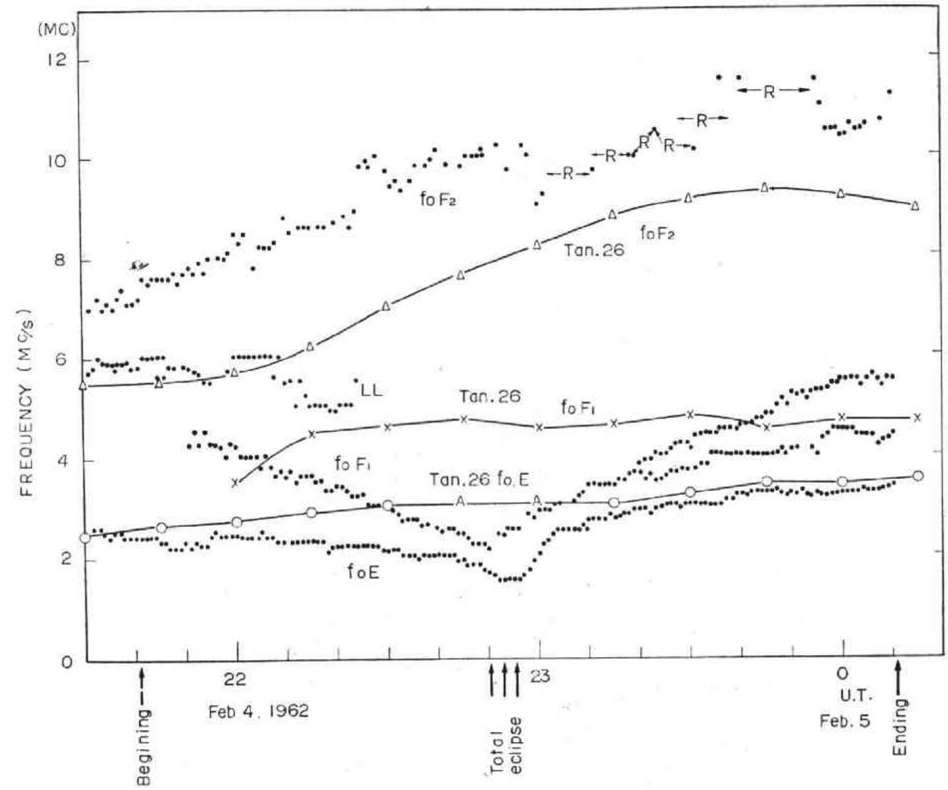

Fig. 7 Result of the ionospheric observation from Radio Research Laboratory.

The boundary is called the magnetopause and its distance is about 10 earth radii from the earth on the dayside.

Fig. 8 is the result of Imp 1 Satelite, published by Ness et al. (5).

Therefore we can expect the shadow of the moon of the corpuscular beam on the boundary of the magnetopause at the time of solar eclipse.

As stated already the magnetic storm occured at the time of solar elcipse of Feb. 5 1962, the shadow of the moon of this corpuscular beam which is the source of this magnetic strom can be expect to lie on the surface of the magnetopause.

This corpuscular eclipse on the magnetopause may excite some kind of hydromagnetic disturbance and it will travel to the earth's surface.

At the time of magnetic strom the boundary of the magnetopause may be compressed inward and the distance of the boundary from the earth becomes shorter than 10 earth radii.

The path of the total corpuscular eclipse on the surface of the magnetopause was calculated, assuming that the velocity of corpuscular was 1150 km/sec and it was emitted from one point on the Sun.

This storm had 27 days recurrent character, that means the storm occured first at 02^h15^m January 10, just before 26 days from the occurrence of this storm.

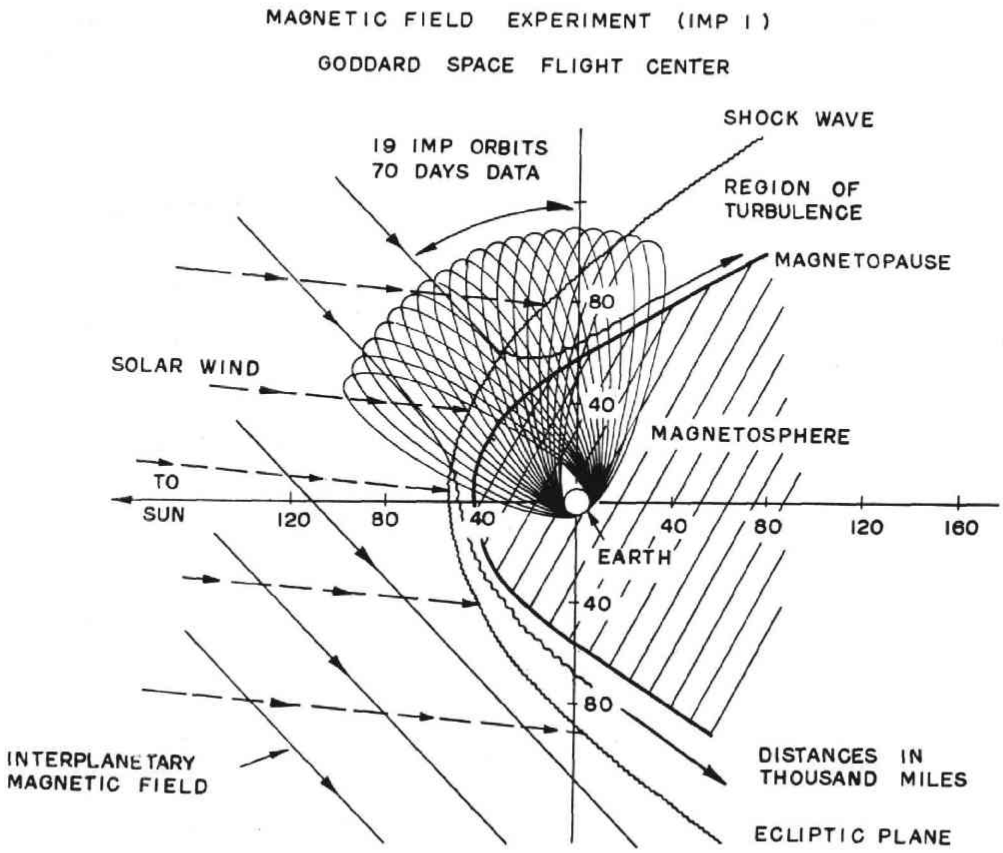

Fig. 8 Result of magnetic field experiment. (after Ness et al.)

Therefore we assumed the velocity of 1150 km/sec after considering the time delay between the onset time of storm and the observed time of flare on the sun, and we assumed that the corpusculers were emitted from this one point on the sun.

Fig. 9–Fig. 12 show the path of the total corpuscular eclipse on the surface of the magnetopause. In this case the magnetopause is assumed as the sphere and calculation was made for the four cases, when its radius in earth radii is $\sigma=7$, $\sigma=5$, $\sigma=3.5$ and $\sigma=2.5$, respectively.

It is very interesting that the shadow of the moon runs from east to west if the radius of the sphere is large while it runs from west to east on the earth's surface, consequently the shadow stops at nearly same place on the surface of the sphere in appropriate case (in this case, the radius of sphere (σ) is 2.5 earth radii).

Another interesting result is that at the time of sunrise or sunset, the shadow of the moon stops on nearly same place in every case.

In the case of sphere whose radius (σ) is 6 earth radii the shadow of the moon stops several hours (from about UT 4^h30^m to UT 7^h30^m) on the surface of the boundary of magnetopause whose longitude is about 150°E and its latitude is between 10°N to

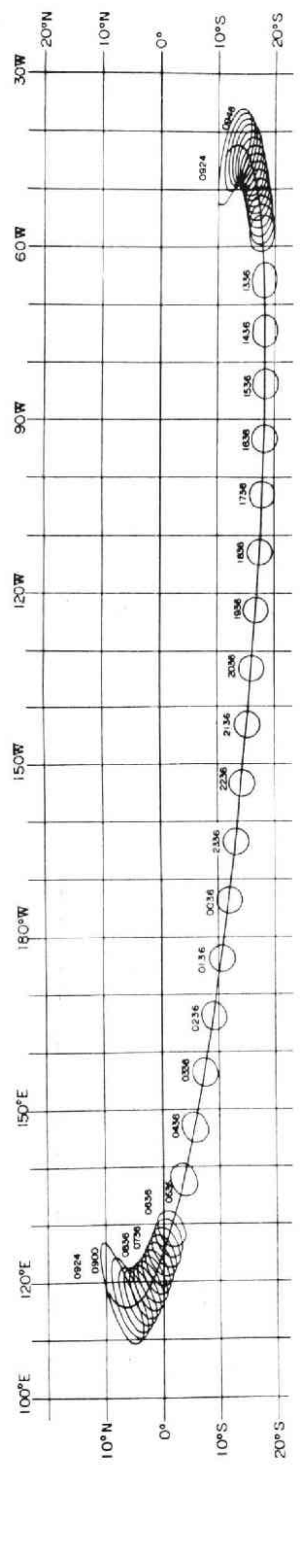

Fig. 9 Path of total zone of corpuscular eclipse on the surface of magnetopause. (radius is 7 Re)

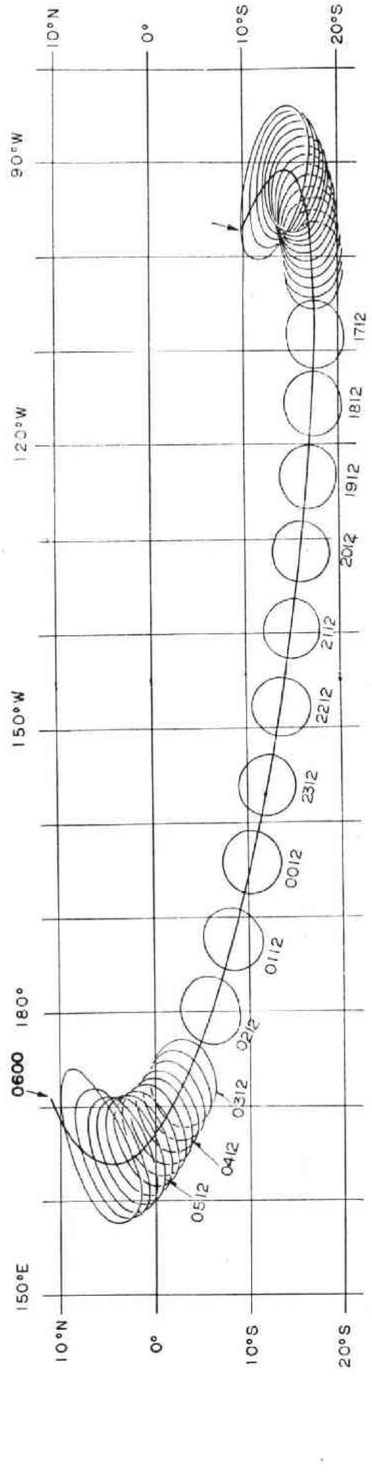

Fig. 10 Path of total zone of corpuscular eclipse on the surface of magnetopause. (radius is 5Re)

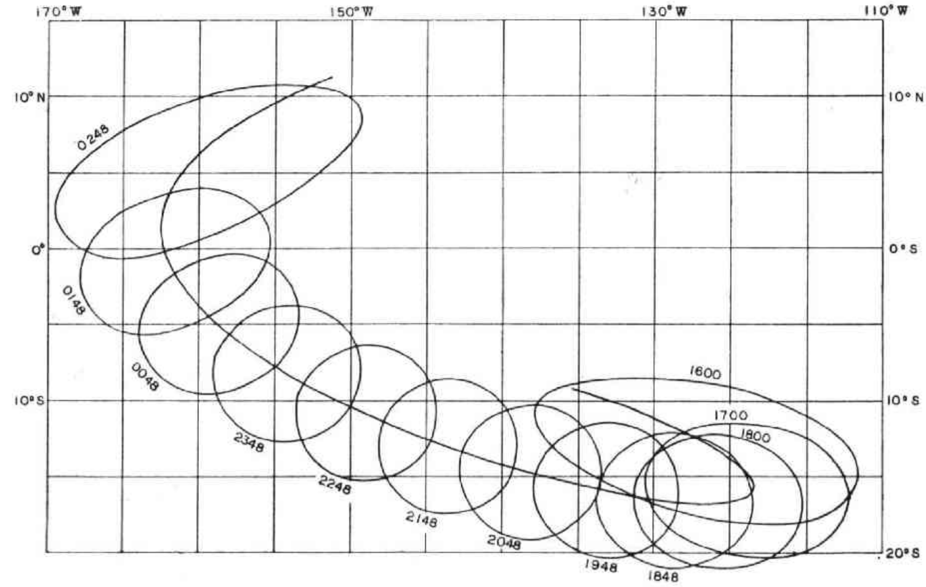

Fig. 11 Path of total zone of corpuscular eclipse on the surface of magnetopause. (radius is 3.5 Re)

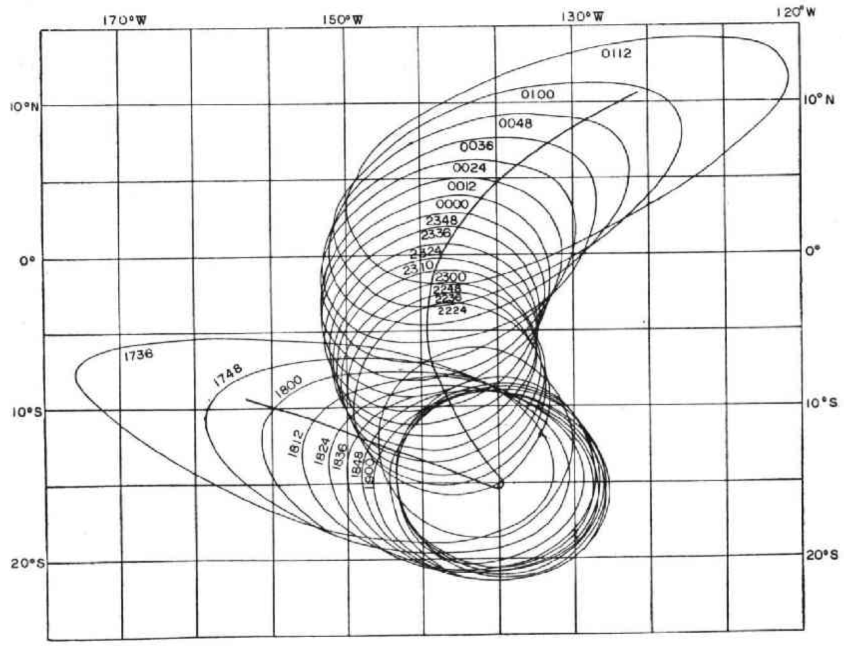

Fig. 12 Path of total zone of corpuscular eclipse on the surface of magnetopause. (radius is 2.5 Re)

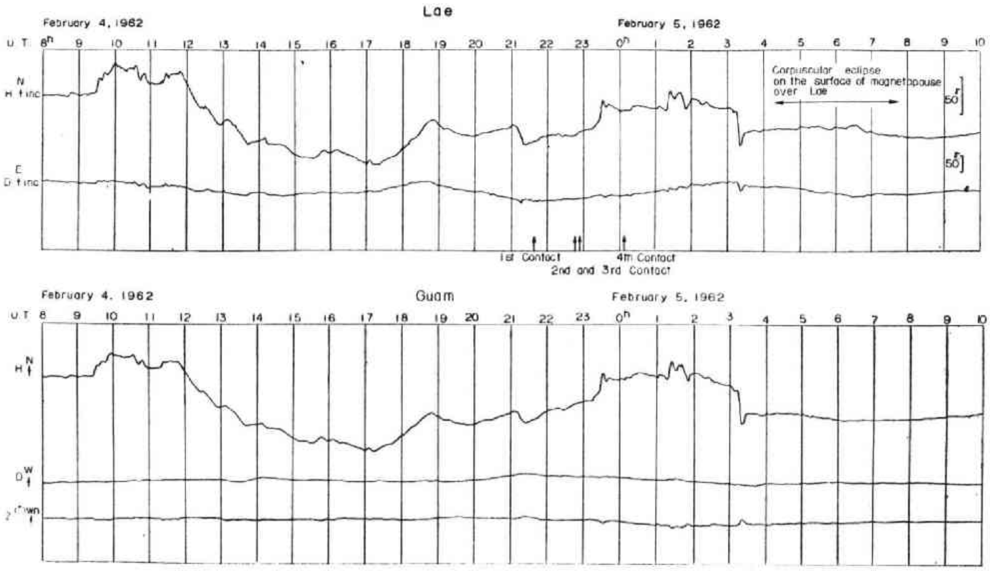

Fig. 13 Magnetograms from Lae and Guam.

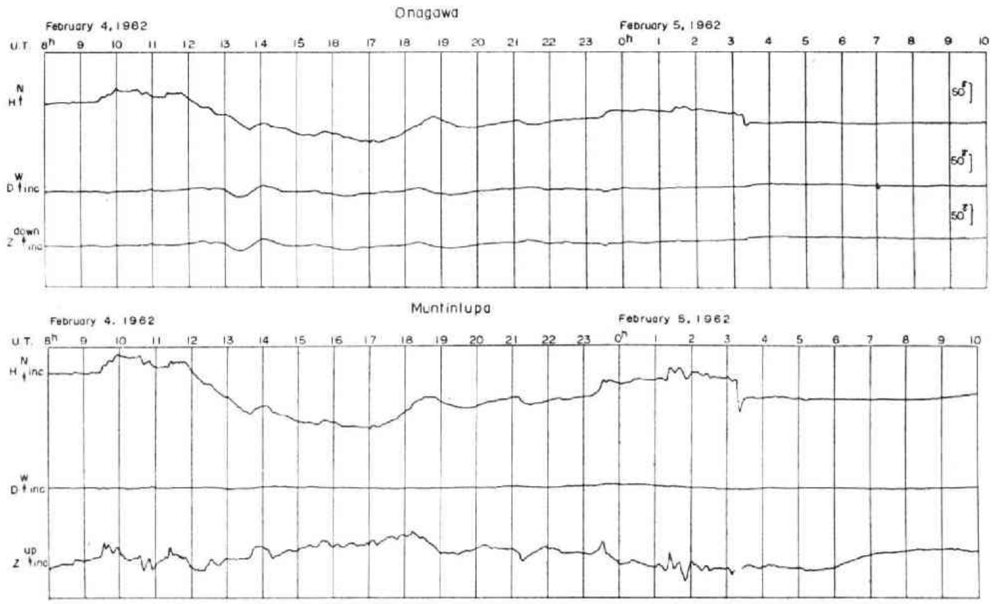

Fig. 14 Magnetograms from Onagawa and Muntinlupa.

10°S, just over the Lae, New Guinea.

Fig. 13–Fig. 16 show the magnetogram from Lae and other places. It is very interesting a distinct magnetic disturbance occured at Lae from UT 4^h30^m to UT 7^h30^m, it just coincides with the time of the corpuscular eclipse above mentioned. This magnetic disturbance ($\Delta H=20\gamma$) was appeared only at Lae and no trace of disturbance

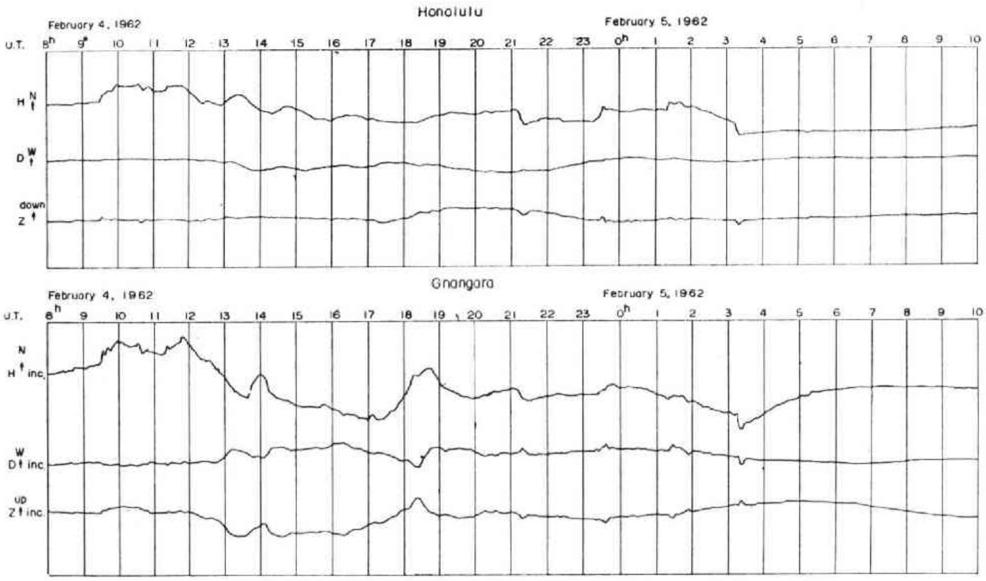

Fig. 15 Magnetograms from Honolulu and Gnangra.

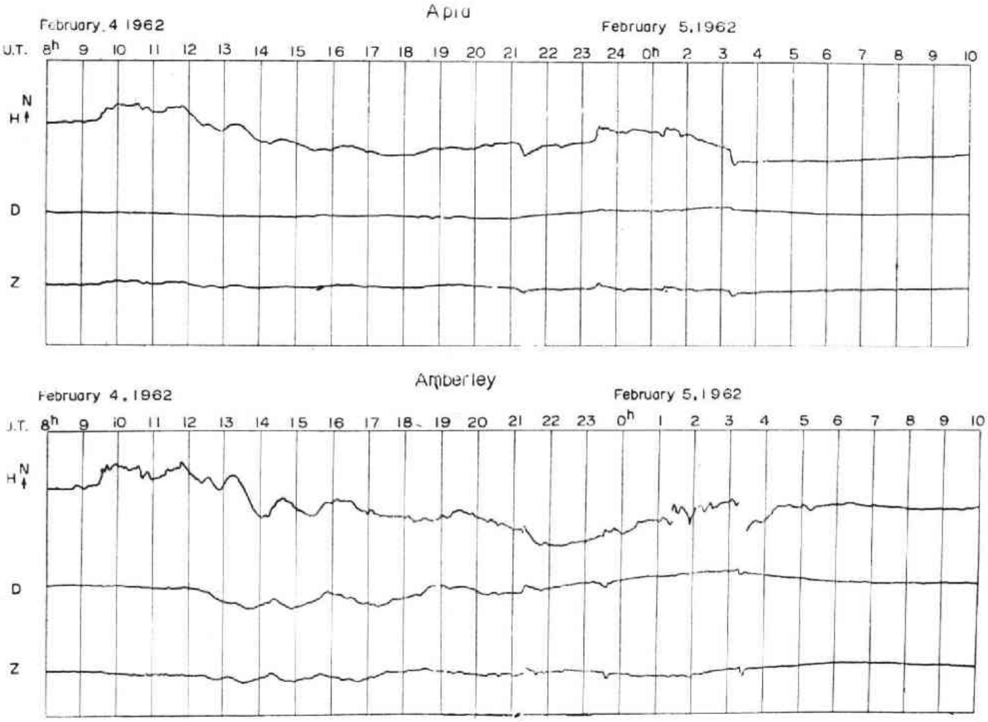

Fig. 16 Magnetograms from Apia and Amberley.

was recorded at another stations. Only at Amberley, there is slight trace of this disturbance. Therefore this is the regional magnetic disturbance.

The author considered that this is the corpuscular eclipse of this magnetic storm on the surface of magnetopause (its radius is six earth radii).

The hydromagnetic wave of long period exicted on the boundary surface of the magnetopause can travel isotropically to the earth's surface.

Anyway, the author considered that this is the another effect of solar eclipse on the earth magnetic field of the solar eclipse of Feb. 5, 1962.

The author expreses his sincere thanks to Mr. N. Yahagi, and Mr. T. Inoue who calculated the paths of corpuscular eclipse and also to Dr. T. Saito who observed the earth magnetic field at Lae with the author.

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